SOIL CONSERVATION PRACTICES AND CROP PRODUCTION IN THE BLACKLANDS OF TEXAS

Conservation Research Report No. 15

AGRICULTURAL RESEARCH SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE
IN COOPERATION WITH
TEXAS AGRICULTURAL EXPERIMENT STATION

Contents

Washington, D.C. Issued November 1971

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 — Price 25 cents
Stock Number 0111–0083

SOIL CONSERVATION PRACTICES AND CROP PRODUCTION IN THE BLACKLANDS OF TEXAS

By Ralph W. Baird and Walter G. Knisel, Jr., *research hydraulic engineers, Soil and Water Conservation Research Division, Agricultural Research Service*[1]

The effects of establishing conservation practices in the farming system on crop production and farm income were of concern to conservationists and farmers when soil conservation work was expanded in the early 1930's. Conservationists and engineers reasoned that reducing soil erosion and controlling storm runoff would increase crop production. However, reasonable estimates of the effects of conservation practices on crop yields could not be made then from available data.

The Blackland Experimental Watershed was established in the Blackland Prairie near Waco, Tex., in 1936 to test the effectiveness of soil conservation practices on controlling erosion and storm runoff. Records were kept of crop yields and land-use practices from watershed areas with and without conservation treatments. The crop yields during 1938–68 are presented in this report.

THE BLACKLAND PRAIRIES OF TEXAS

The major Blackland Prairie includes about 9 million acres and the two minor prairies comprise about 2.5 million acres (fig. 1).[2] The western boundary of the major prairie extends from near the Red River about 15 miles west of Sherman, Tex., southerly through Waco, Austin, and San Antonio—a distance of about 300

---

[1] During 1950–63 James B. Pope, agronomist at the Blackland Experimental Watershed, was responsible for planning the changes in treatment on the conservation watershed and for the records of crop yields until his retirement in 1963. Roy B. Sturdevant, Chester A. Thomas, and E. W. Ehlers, Jr., kept records of farm operation and crop yields during 1964–68.

[2] Godfrey, C. L. the soils of the blackland prairies. Tex. Agr. Expt. Sta. Misc. Pub. 698, 23 pp. 1964.

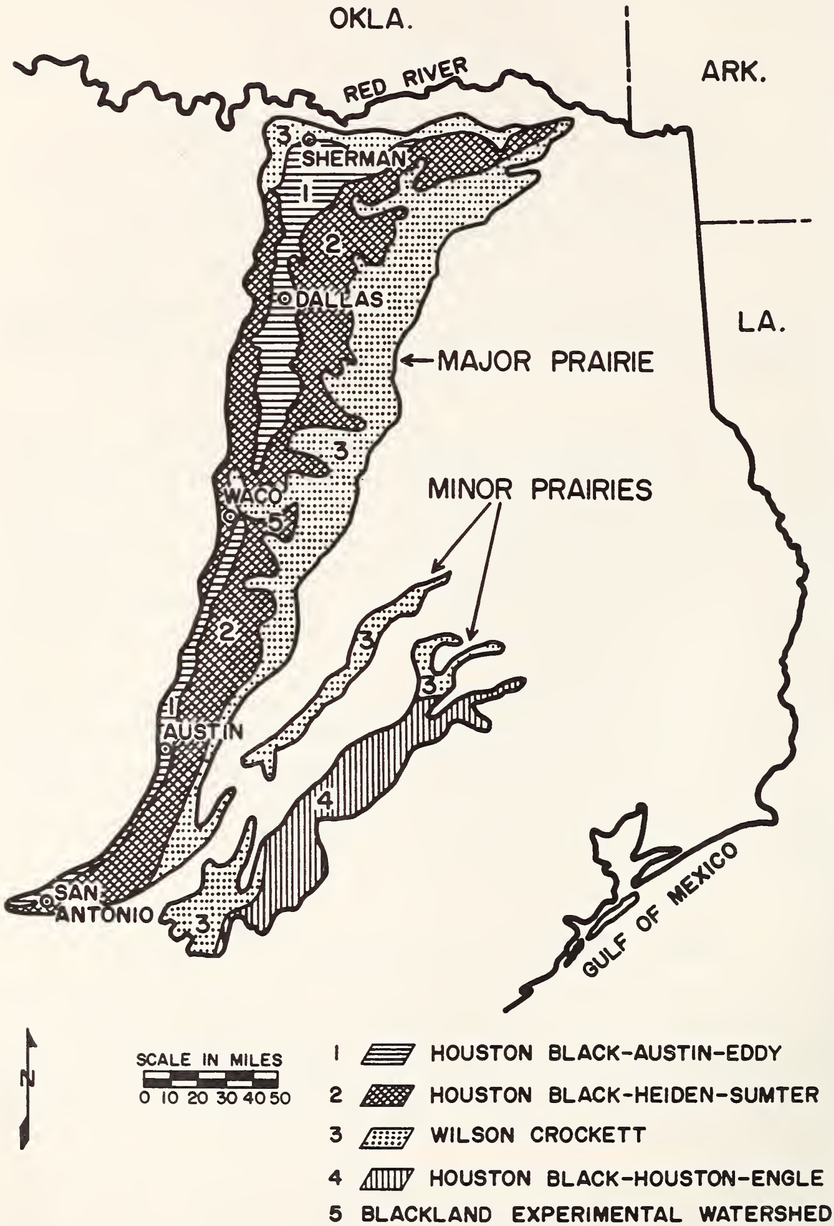

FIGURE 1.—General soils map of the Blackland Prairies.

miles. The prairie is about 75 miles wide near the Red River decreasing to about 15 miles near San Antonio.

Houston Black clay and related soils occupy approximately one-half the area of the Blackland Prairies. These soils are calcareous, dark colored, montmorillonitic clays that swell when wet and shrink as they dry. In prolonged dry periods soil cracks develop to 3 to 4 inches wide and 4 to 5 feet deep. These soils are very slowly permeable when wet but absorb water rapidly when dry.

Many of the deep, black clay soils had been intensively cultivated before 1938 with cotton the major crop and corn grown on a much smaller area. Clean cultivation, intensive use of crop residues by livestock, and limited equipment to incorporate crop residues into the soil had led to severe erosion losses. Many areas on the steeper slopes and those where runoff water concentrated from upstream areas were severely gullied.

The climate of the area is characterized by long, hot summers and short, relatively mild winters. Annual precipitation, annual temperatures, and length of growing season at five locations are shown in table 1.

TABLE 1.—*Climatic data for 5 locations in Blackland Prairie* [1]

Location	Annual precipitation	Annual temperatures		Length of growing season
		Maximum	Minimum	
	Inches	° *F.*	° *F.*	*Days*
Sherman	39.05	113	−2	227
Dallas	34.55	111	−3	235
Waco	32.08	111	−5	253
Austin	32.58	109	−2	270
San Antonio	27.84	107	0	265

[1] From "Texas Almanac 1968–69," Office of Environmental Science Services Administration, State Climatologist. Data were from latest compilation by ESSA as of Jan. 1, 1967.

The highest monthly precipitation usually occurs during April, May, and June with a relatively dry period during July and August. The lowest precipitation in July and August is more pronounced and the increased amount in September is less pronounced at Waco and Dallas than at the other locations. Precipitation distribution varies greatly from the average, and large or small amounts may occur any month of the year.

THE BLACKLAND EXPERIMENTAL WATERSHED

The Blackland Experimental Watershed is located about 20 miles southeast of Waco, Tex., near the center of the major Blackland Prairie (fig. 1). Records were maintained of rainfall, runoff, sediment, and land use for about 4,000 acres of privately owned land and for 840 acres of federally owned land, where more intensive studies are conducted.

The soils of the experimental watershed were formed from Taylor marl. On the privately owned land, Houston Black clay and associated soils occur on about 70 percent of the area with Heiden, Wilson, and Crockett soils on the remainder. The Government-owned land is more uniform with Houston Black clay on 70 percent of the area and associated soils on the remainder.

The topography is typical of much of the major prairie with slopes of 1 to 3 percent occurring on about 75 percent, slopes of 3 to 6 percent on about 20 percent, and slopes of less than 1 percent on the remainder of the area. Drainage is through broad, flat valleys that are flooded during major runoff. Small, incised channels that carry only minor flows may occur in the lower part of the valleys.

Climate

The climate at the Blackland Experimental Watershed is much like that shown for Waco in table 1. The annual precipitation ranged from 18.22 inches in 1954 to 58.43 inches in 1957 with an average of 33.71 inches (table 4, Appendix). Precipitation is highest during April, May, and June, averaging 4.03, 4.46, and 3.59 inches, respectively, but as little as 0.52, 0.66, and 0.28 inches have occurred in these same 3 months. During the 31 years less than 1 inch of rainfall has been recorded in 14 years in July and in 11 years in August, but more than 5 inches have been recorded at least once for each month of the year. The maximum monthly precipitation of 15.65 inches occurred in April 1957 (table 4, Appendix).

Excess precipitation during the winter and early spring makes preparation of the heavy clay soils and timely planting of cotton, corn, and grain sorghum difficult. The largest crop yield is usually obtained when there is a good reserve of soil moisture in the early spring and near average rainfall in late spring and early summer.

Experimental Practices and Procedures

Two adjoining watersheds of about 300 acres each on Government-owned land were selected for detailed studies of runoff, sediment yields, and crop production. On these watersheds conservation practices could be established and land uses controlled. This report is limited to a study of crop yields from these two watersheds.

For 5 years (1938–42) both watersheds were farmed alike with crops and practices commonly in use in 1937. This included cultivation of about 80 percent of the area in a rotation of cotton, corn, cotton, oats with cotton on one-half, corn on one-fourth, and oats on one-fourth of the cultivated land each year. This cropping system was used through the 1942 crop year on both watersheds. It was continued on one watershed through 1968.

On the other watershed a conservation program was established in the fall of 1942. It included increasing the area of permanent grasses, terracing cultivated fields, establishing sodded waterways where needed, and changing from the 4-year to a 3-year rotation with fall-seeded oats and sweetclover, cotton, and corn (sequence A). A cropping sequence of oats and sweetclover, corn, and cotton (sequence B) also was used on three small fields of the conservation watershed to obtain information regarding the more desirable sequence of crops. Yields of the crops in sequence B were obtained separately and were not included in the yields from the major section of the conservation watershed. Starting in 1957 grain sorghum gradually replaced corn, and no corn has been grown on either watershed since 1966.

Cropping and Tillage Practices

Bedding and rebedding with straight rows, without regard to topography, was the common tillage practice before planting cotton and corn on both watersheds in 1938. Frequent cultivation during the spring and early summer was the usual practice. Oats were drilled in the cotton stalks after cotton harvest was completed. Most of these farming operations were done with one-row, animal-drawn implements. After 1942 the 4-year system was continued on the nonconservation watershed but with gradual changes from use of one-row, animal-drawn equipment to two-row tractor and later four-row tractor equipment.

On the conservation watershed the change to the 3-year rotations with terraces required changes in field layout. Rows were regularly laid out parallel to the upper terrace in each terrace interval with point row areas in the terrace channels. Beginning

in 1946 oat stubble and sweetclover on the conservation watershed were plowed with tractor-drawn, two-way plows with the dead furrow in the terrace channel. This procedure maintained terraces with only occasional extra work in the outlets or low places in terrace ridges. To avoid the development of a deep, dead furrow in the terrace channel, occasional plowing was done turning all furrows upslope (fig. 2).

Bedding and rebedding, without plowing, was the usual practice where a row crop followed a row crop, but occasionally fields of grain sorghum or corn were plowed and bedded after the stalks were shredded. Oats and oats with sweetclover were drilled and fertilizer was applied after shredding stalks and disking.

Changes in farm machinery have affected both watershed areas. The change from binders and threshers to grain combine for harvesting oats has resulted in more crop residue being left in the fields and incorporated into the soil. Stalk shredders, used since about 1950 in fields of grain sorghum, corn, and cotton, have resulted in better utilization of crop residues. The use of cotton desiccants and strippers for cotton harvest has resulted in earlier completion of cotton harvest and earlier preparation of land in the fall or early winter for the next year's crop. Also, with larger tractor equipment, plowing to a depth of 8 inches is common rather than the 3- to 4-inch depth used in 1936.

Crop varieties were changed on both watersheds as new and improved varieties with greater yield potential became available.

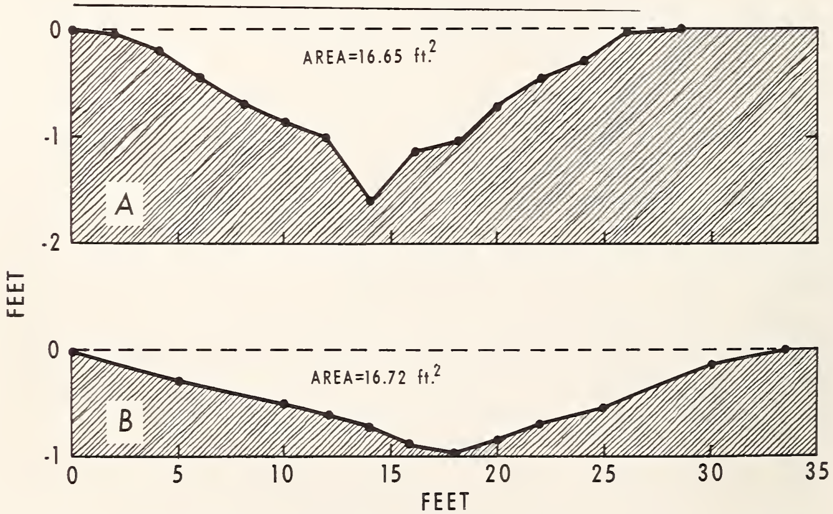

FIGURE 2.—Cross section of terrace channels plowed with two-way plow: *A*, Dead furrow in terrace channel; *B*, no dead furrows in field.

Fertilizer Use

Regular use of commercial fertilizers was not common in the Blacklands area until the late 1940's, and they were not included in the original experimental plan for the conservation and nonconservation watersheds.

The use of commercial fertilizers was started on the conservation watershed in 1949 (table 5, Appendix). Regular use of fertilizers on the nonconservation watershed was initiated in 1962 to be comparable to the common practices in the Blacklands.

Crop Yields

The conservation program included several land-use and treatment changes that were expected to affect crop yields. Some treatments affected crop yields both directly and indirectly. The integrated conservation practices resulted in less erosion and runoff, which in turn affected crop yield, i.e., less erosion resulted in more plant nutrients retained for crop production, and less runoff resulted in more water retained for the efficient use of plant nutrients for crop production.

Sediment yield from the conservation watershed was reduced to about 12 percent of that from the nonconservation watershed.[3] Terraces with the 3-year rotation and other conservation practices reduced the amount of storm runoff about 23 percent during 1949–66 after the conservation program had been used for 6 years. However, terraces without the conservation program had little effect on the amount of storm runoff.[4] This program also required time before crop yields were increased (table 6, Appendix).

The conservation program as planned in 1942 included a 3-year rotation of oats-sweetclover (grown as a soil-improving crop), cotton, and corn. As all three crops were grown each year, the soil-improving crop (oats-sweetclover) might have affected crop yields on one-third of the cultivated area the second year but could not affect all crops until the fourth year of the rotation. During the first 3 years the clover made little growth. Growth improved appreciably when phosphorus fertilizer was applied on the 1949 crop of oats-sweetclover.

---

[3] Baird, R. W. SEDIMENT YIELDS FROM BLACKLAND WATERSHEDS. Amer. Soc. Agr. Engin. Trans. 7 (4): 454–456. 1964.

[4] Baird, R. W., Richardson, C. W., and Knisel, W. G. EFFECTS OF CONSERVATION PRACTICES ON STORM RUNOFF IN THE TEXAS BLACKLAND PRAIRIE. U.S. Dept. Agr. Tech. Bul. 1406, 31 pp. 1970.

Crop yields were analyzed statistically for periods without major changes on either watershed. During 1938–42, when the same rotation and practices were used on both watersheds, there were no significant differences in the yields of lint cotton, corn, or oats from the two watersheds. Annual crop yields from the conservation and nonconservation watersheds are given in table 6 (Appendix).

Cotton

Cotton production in the Blacklands of Texas is greatly affected by climate. Untimely rains increase cotton root rot and insect damage. After the crop is mature, rains may cause harvest losses and lower lint quality.

During 1943–49 the average lint cotton yields from the two watersheds were not significantly different (table 2, fig. 3). Without fertilizer and with difficulty in obtaining good inoculation, the sweetclover growth was small and probably had little effect on cotton yield.

During 1950–62 the increased yield of lint cotton from the conservation watershed was significant—62 percent more than from the nonconservation watershed. The combined effects of the fertilizer and increased growth of clover cannot be separated from results for this period.

During 1963–65 lint cotton production from both watersheds was above average. Although more fertilizer was used on the nonconservation watershed on all crops and no fertilizer was applied directly on cotton on the conservation watershed, cotton yields from the nonconservation watershed were only 59 percent of those from the conservation watershed—a large and significant difference.

During 1966–68 no fertilizer was applied on lint cotton on the nonconservation watershed and the yield was 52 percent of that from the conservation watershed. The much larger cotton yields from the conservation watershed than from the nonconservation watershed during 1963–65 and 1966–68 indicate that some treatment in addition to fertilizer use is needed to increase cotton yields from the nonconservation watershed.

There was no significant difference in lint cotton yield from the nonconservation watershed during 1938–47 as compared with cotton yield during 1959–68. Precipitation was comparable for these two periods: Average annual precipitation of 36.32 inches (1938–47)—above average for 6 years; and 35.93 inches (1959–68)—above average for 5 years. The 31-year average precipitation

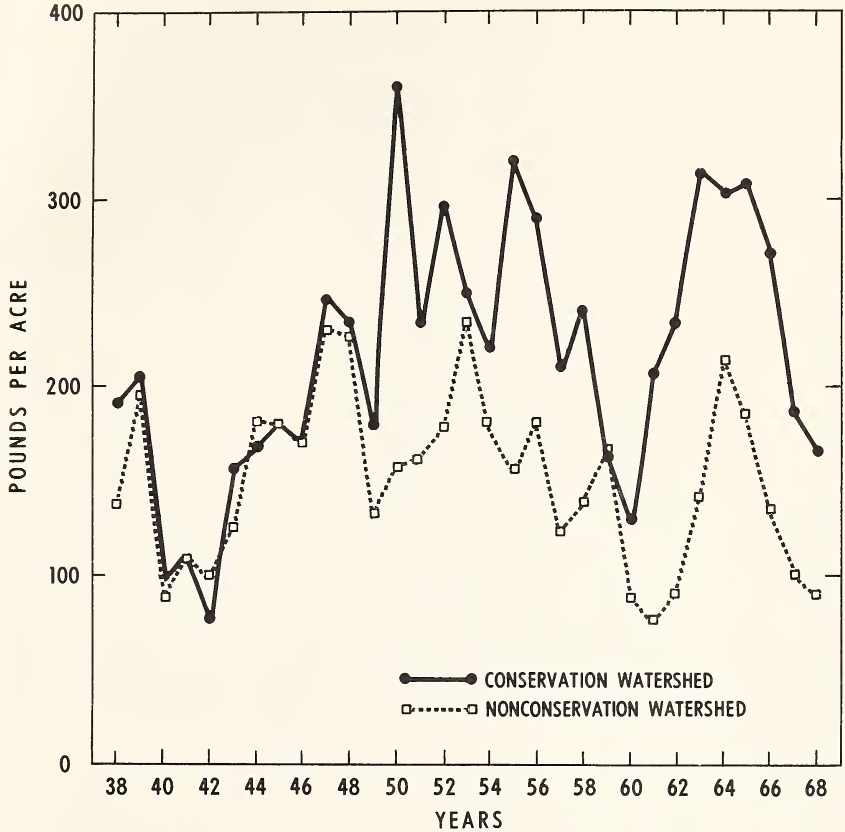

FIGURE 3.—Annual yields of lint cotton from two watersheds, 1938–68.

was 33.71 inches. During the 31 years very wet years seldom produced high cotton yields. For the 12 years with less than 28.71 inches of rainfall, average lint cotton yield from the nonconservation watershed was 166 pounds per acre. For the 8 years with 28.71 to 38.70 inches of rainfall, near average lint cotton yield was 145 pounds per acre. For the 11 years with more than 38.70 inches of rainfall, average lint cotton yield was 139 pounds per acre.

Oats and Oats With Sweetclover

Oats were grown on both watersheds during 1938–42 and on the nonconservation watershed during 1943–68. On the conservation watershed Hubam clover was fall planted with the oats during 1943–53 and caused difficult combine harvesting in some years because of excessive green clover at harvest. Madrid sweetclover

TABLE 2.—*Average yields and treatments for 4 crops on conservation and nonconservation watersheds during various periods, 1938–68*

Period	Average yield per acre: Conservation watershed	Average yield per acre: Non-conservation watershed	Difference [1]	Treatment [2]
LINT COTTON				
	Pounds	*Pounds*	*Pounds*	
1938–42	136.3	125.7	10.6 N.S.	Nonconservation treatment on both watersheds; no fertilizer; rotation of cotton, corn, cotton, and oats.
1943–49	190.5	178.3	12.2 N.S.	Terraces; rotation of oats-sweetclover, cotton, and corn on conservation watershed; no fertilizer.
1950–62	241.8	149.0	92.8*	Fertilizer only on oats-sweetclover on conservation watershed.
1963–65	307.1	180.8	126.3*	Fertilizer on all crops on nonconservation watershed and on cotton (sequence B) and oats-sweetclover on conservation watershed.
1966–68	207.1	108.3	98.8*	Fertilizer only on oats and corn or grain sorghum on nonconservation watershed and on cotton (sequence B) and oats-sweetclover on conservation watershed.
OATS				
	Bushels	*Bushels*	*Bushels*	
1938–42	34.5	36.6	−2.1 N.S.	4-year rotation of cotton, corn, cotton, and oats; no fertilizer on either watershed.
1943–48	24.5	27.0	−2.5 N.S.	Terraces; rotation of oats-sweetclover, cotton, and corn; no fertilizer.
1949–62	34.6	28.6	6.0 N.S.	Fertilizer only on oats-sweetclover on conservation watershed.
1963–68	46.9	49.8	−2.9 N.S.	Fertilizer on all crops on nonconservation watershed (1963–65) and only on oats and corn or grain sorghum (1966–68). Fertilizer on all oats-sweetclover and on cotton (sequence B) on conservation watershed.

CORN				
	Bushels	*Bushels*	*Bushels*	
1938–42	23.2	24.4	−1.2 N.S.	Both watersheds same—4-year rotation of cotton, corn, cotton, and oats; no fertilizer.
1943–49	23.6	22.3	+1.3 N.S.	Terraces, 3-year rotation, and no fertilizer on conservation watershed.
1950–61	32.2	25.4	+6.8*	Fertilizer only on oats-sweetclover on conservation watershed.
1962–66	33.7	40.9	−7.2 N.S.	Fertilizer only on corn on nonconservation watershed. Fertilizer on all oats-sweetclover and on cotton (sequence B) on conservation watershed.
GRAIN SORGHUM				
	Pounds	*Pounds*	*Pounds*	
1957–62	2,781	1,663	1,118*	Conservation watershed: Rotation of oats-sweetclover, cotton, and grain sorghum; fertilizer only on oats-sweetclover. Nonconservation watershed: Rotation of cotton, grain sorghum, cotton, and oats; no fertilizer.
1963–68	2,732	2,396	336 N.S.	Conservation watershed: Rotation of oats-sweetclover, cotton, and grain sorghum; fertilizer on oats- sweetclover and cotton (sequence B). Nonconservation watershed: Rotation of cotton, grain sorghum, cotton, and oats; fertilizer on grain sorghum and oats and on cotton (1963–65).

[1] N.S. = differences not significant at 5-percent level; * = differences significant at 5-percent level.
[2] See table 5 (Appendix) for fertilizer application.

was planted with the oats during 1954–68. It is an annual in this area when planted in the fall. Spring growth of Madrid sweetclover is slower than for Hubam clover and causes less difficult harvesting. In some years it produces a profitable seed crop after oat harvest.

There was no significant difference in yield of oats from the two watersheds for any of the periods (table 2, fig. 4). The sweetclover grown with oats on the conservation watershed increased harvest losses some years and may have reduced oat yield by competition for moisture in dry years. The small application of fertilizer (table 5, Appendix) on the oats-sweetclover (1949–68) probably had little or no carryover effect on the following crops of cotton, corn, or grain sorghum. Increases in yields of these crops on the conservation watershed probably were caused largely by the legume crop in the rotation.

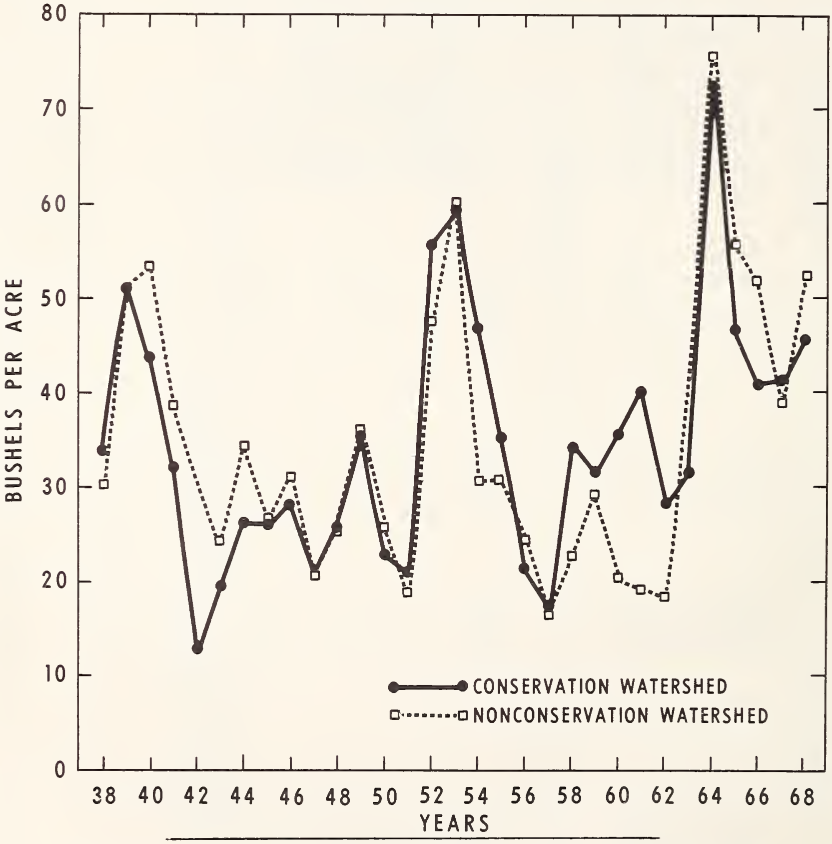

FIGURE 4.—Annual yields of oats from two watersheds, 1938–68.

Oat areas on both watersheds were grazed by cattle through the winter until late February, and sweetclover on the conservation watershed provided some additional grazing after harvest of the oats. The value of the grazing was considerable but difficult to evaluate. Probably grazing caused some reduction in yield of oat grain.

Corn

No fertilizer was used on either watershed during 1943–49, and the small differences in yield were not significant (table 2, fig. 5). Yields of corn were low on both watersheds (fig. 5).

Corn yield increased on the conservation watershed during 1950–61 and was probably caused by the effect of the legume crop in the rotation. Sweetclover made good growth when fertilizer was applied to the oats-sweetclover. Although cotton was grown the year following oats-sweetclover, the 27-percent increase in corn yield compared with the corn yield from the nonconservation area was important and significant.

The use of fertilizer on all crops during 1963–65 and on corn during 1966 on the nonconservation watershed caused an appreciable increase in corn yields with no significant difference between watersheds.

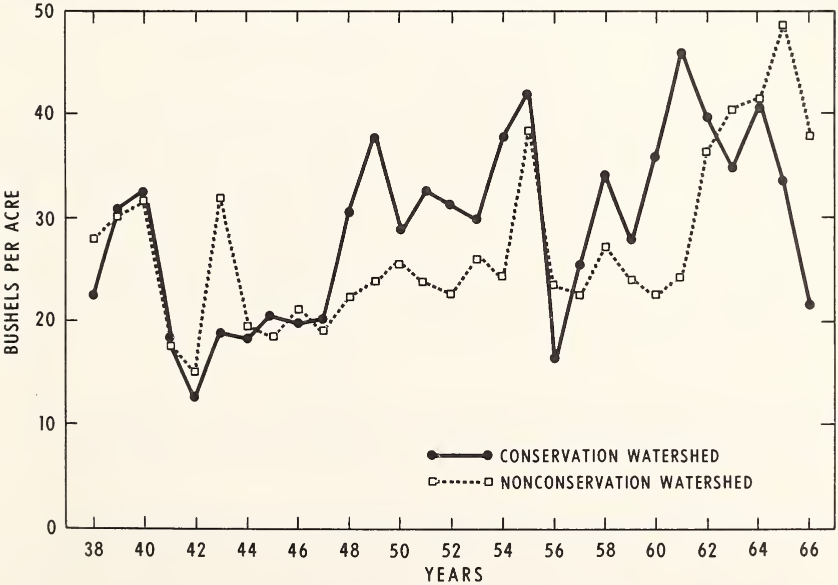

FIGURE 5.—Annual yields of corn from two watersheds, 1938–66.

Although corn yields have increased with increased use of fertilizers, the improved varieties of grain sorghum have produced more grain than corn. Since 1957 corn has gradually been replaced by grain sorghum in the area, and corn has not been grown on the experimental watersheds since 1966.

Grain Sorghum

Improved varieties of grain sorghum became available in the early 1950's. The earlier combine harvesting of grain sorghum makes possible earlier fall tillage and better weed-control practices with grain sorghum than with corn. By 1957 grain sorghum had replaced corn in some of the rotations on the experimental watershed.

During 1957–62 grain sorghum on the conservation watershed produced 60 percent more grain than the grain sorghum without fertilizer on the nonconservation watershed — an important and significant difference (table 2, fig. 6).

During 1963–68 grain sorghum yields increased on the nonconservation watershed with fertilizer used on all crops during 1963–65 and on oats and grain sorghum during 1966–68 in the 4-year rotation. The yield was 12 percent less than yield of grain sorghum from the conservation area for this period—a nonsignificant difference.

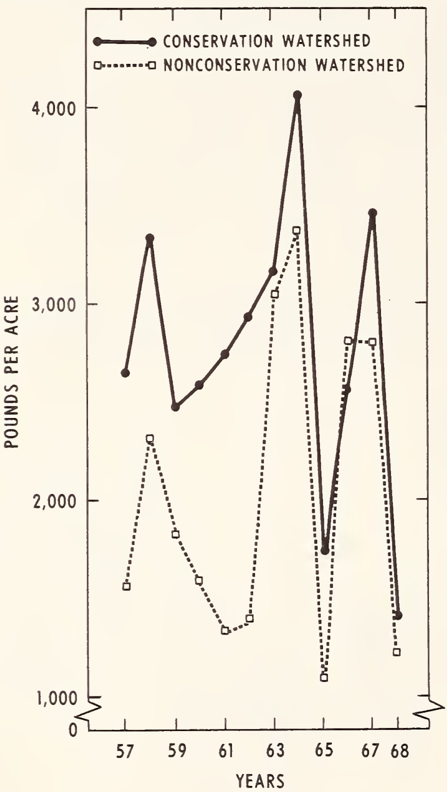

FIGURE 6.—Annual yields of grain sorghum from two watersheds, 1957–68.

Effect of Crop Sequence on Crop Yields in 3-Year Rotation

When the crop rotations were planned for the conservation watershed, no information was available regarding the more desirable sequence of crops in the 3-year rotation of oats-sweetclover,

cotton, and corn (sequence A) or oats-sweetclover, corn, and cotton (sequence B). Therefore during 1956–61 the sequence of oats-sweetclover, grain sorghum, and cotton (sequence B) was used on three small fields on the conservation watershed so that each crop would be grown on one field each year. The fertilizer was applied to the oats-sweetclover only so comparisons could be made with the oats-sweetclover, cotton, and grain sorghum (sequence A) used on the major part of the conservation watershed. The difference in grain sorghum yields was significant (table 3), but the effects on yields of oats and lint cotton were not significant.

During 1962–68 additional fertilizer was used on cotton in the oats-sweetclover, grain sorghum, and cotton (sequence B). Differences in yields of the three harvested crops were nonsignificant. The value at 1968 prices of the increased yield of oats and lint cotton from the oats-sweetclover and cotton in the oats-sweetclover, grain sorghum, and cotton rotation (sequence B) was about twice the cost of the additional fertilizer applied.

DISCUSSION

During 1938–42 almost 80 percent of each watershed was in cultivation and the remainder in permanent grasses. Small areas were in native grasses cut for hay, and the pastures were used primarily by cattle and mules or horses.

The conservation plan established on the conservation watershed during 1942–43 included an increase in grassland for grazing from 61 acres during 1938–42 to 95 acres in 1943. The grassland was gradually increased to 124 acres in 1968. The areas changed to pasture included some of the steeper cultivated sections, areas along drainageways that were subject to overflow from large runoff, and small areas resulting from the revision of field boundaries to eliminate some of the very short rows in irregularly shaped fields.

The changes to pastureland on the watershed without conservation practices followed a similar pattern. Grassland for grazing was increased from 62 acres during 1938–43 to 120 acres in 1968.

With improved practices on the grassland and better management of livestock, returns from grasslands are now an important part of income from farmlands. Grasslands can be managed to carry a cow and calf on about 3 acres with little supplemental feeding.

TABLE 3.—*Effects of crop sequence and fertilizer use on yields of oats, lint cotton, and grain sorghum from conservation watershed, 1956–68*

Crop harvested	Average yield per acre		Difference [1]	Fertilizer use [2]
	Sequence A—(oats-sweetclover, cotton, grain sorghum)	Sequence B—(oats-sweetclover, grain sorghum, cotton)		
1956–61				
Oats ..... bushels	31.4	28.2	3.2 N.S.	Fertilizer on oats-sweetclover, none on other crops (both sequences).
Lint cotton ..... pounds	187.6	189.1	1.5 N.S.	
Grain sorghum ..... do	2,410.0	2,583.0	173.0*	
1962–68				
Oats ..... bushels	41.7	47.3	5.6 N.S.	Fertilizer only on oats-sweetclover (sequence A) and on oats-sweetclover and cotton following grain sorghum (sequence B).
Lint cotton ..... pounds	229.4	266.3	36.9 N.S.	
Grain sorghum ..... do	2,616.0	2,642.0	26.0 N.S.	

[1] N.S. = differences not significant at 5-percent level; * = differences significant at 5-percent level.

[2] See table 5 (Appendix) for fertilizer application.

SUMMARY

The Blackland Experimental Watershed is comparable to much of the Blackland Prairies. The effects of conservation practices and fertilizer use on crop production are applicable to much of the Blackland Prairies. Significant differences in crop yields from the two watersheds were not obtained until after phosphorus fertilizer was used in 1949.

Lint cotton yields during 1950–68 from the conservation watershed with the 3-year rotation—oats-sweetclover, cotton, and corn or grain sorghum with fertilizer used only on the oats-sweetclover—were significantly greater than from the nonconservation watershed with a 4-year rotation—cotton, corn, cotton, and oats. The use of phosphorus and nitrogen fertilizer on all crops on the nonconservation watershed had little effect on the cotton yields during 1963–65.

Oat yields from the two watersheds did not differ significantly for any of the periods tested. The use of sweetclover as a soil-improving crop with oats on the conservation watershed probably caused some reduction in oat yields because of competition for moisture and nutrients and increased harvest losses.

Corn yields on the conservation area the second year after fertilized oats-sweetclover were significantly more than yields of nonfertilized corn on the nonconservation watershed. However, application of fertilizer to corn on the nonconservation watershed increased yields sufficiently so that the difference in yield from the two watersheds was not significant.

Grain sorghum yields were significantly greater from the conservation watershed during 1957–62 than from the nonconservation watershed without fertilizer. The application of nitrogen and phosphorus fertilizers on the nonconservation watershed increased grain sorghum yield sufficiently so that the difference in yield between the two watersheds was not significant during 1963–68.

CONCLUSIONS

Cotton in the Texas Blacklands apparently needs some treatment in addition to fertilizer to cause appreciable increases in yield. In this study the use of sweetclover with application of fertilizers 1 year in the 3-year rotation has been more effective than application of fertilizer to cotton. Oats, corn, and grain sorghum on the nonconservation watershed have responded with increased yields the year fertilizers were applied. Fertilizer rates for maximum profit were not a part of this study.

APPENDIX

TABLE 4.—*Monthly and annual precipitation at Blackland Experimental Watershed, 1938–68, RG 69* [1]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1938	3.99	2.71	2.76	4.01	2.50	3.20	1.58	0.74	0.96	0.16	0.83	2.63	26.07
1939	3.83	2.90	1.16	.81	4.57	2.65	.30	2.19	.73	1.71	2.22	.96	21.03
1940	.94	2.47	.52	4.36	1.88	6.41	1.72	3.00	1.09	4.00	10.25	3.77	40.41
1941	2.82	5.47	3.61	4.24	4.98	6.86	3.55	1.35	.82	3.49	2.18	2.47	41.84
1942	.65	1.72	1.13	6.68	4.31	8.14	.71	1.13	8.29	2.30	3.14	3.53	41.73
1943	1.01	.13	2.20	1.51	5.02	2.58	3.52	.29	1.85	2.86	1.92	3.13	26.02
1944	4.83	5.75	3.84	7.07	12.56	1.55	1.98	1.51	1.76	.14	6.70	4.44	52.13
1945	2.44	2.97	7.48	5.85	3.08	3.88	1.81	4.63	3.51	3.09	1.06	5.02	44.82
1946	3.18	3.06	4.14	2.87	9.02	2.33	1.23	1.75	4.71	1.61	4.86	2.40	41.16
1947	3.86	.57	4.34	2.76	4.28	.35	.78	1.39	1.44	.22	1.39	3.65	25.03
1948	2.17	1.96	1.03	5.53	5.50	1.38	1.25	.64	1.79	.64	1.13	1.43	24.45
1949	1.90	1.68	2.55	4.03	1.14	4.90	5.19	1.59	.20	4.45	.23	2.98	30.84
1950	1.98	3.59	.25	3.65	3.03	2.45	1.77	.08	2.71	.91	1.14	.40	21.96
1951	1.18	2.39	1.76	2.61	3.11	4.36	.02	.11	5.92	.66	1.02	.49	23.63
1952	1.78	2.79	3.23	5.26	5.11	1.18	.61	0	.63	0	7.08	4.73	32.40
1953	.57	1.81	3.72	3.15	5.98	.51	.35	3.60	1.78	5.70	.94	4.36	32.47
1954	1.28	.73	.41	3.52	3.82	1.40	1.55	.43	1.23	.82	2.86	.17	18.22
1955	2.29	4.18	4.04	2.50	5.70	3.78	1.05	1.12	1.14	1.16	.87	.81	28.64
1956	2.32	2.33	.33	.58	4.63	1.94	1.61	2.54	0	.43	4.47	1.92	23.10
1957	1.57	3.25	5.64	15.65	8.48	4.21	.01	1.24	4.45	8.48	4.72	.73	58.43
1958	1.87	3.44	2.13	3.20	2.11	2.68	.97	5.57	5.62	3.16	1.39	1.41	33.55
1959	.37	3.27	.90	4.01	4.02	7.37	4.45	3.20	1.97	6.64	2.09	3.66	41.95
1960	2.06	2.13	1.63	1.87	1.90	4.69	.49	3.21	.48	5.50	2.26	7.03	33.25
1961	5.04	4.54	2.05	.52	2.49	8.17	4.00	.25	4.76	1.91	2.17	1.84	37.74

1962	1.31	1.47	1.06	3.64	2.46	5.29	.15	.09	2.02	2.78	3.98	1.22	25.47
1963	.52	1.29	.88	2.25	1.97	2.89	.17	.75	.44	2.36	3.47	1.79	18.78
1964	3.34	2.06	2.12	4.77	.66	2.24	.04	5.87	4.88	.99	3.52	1.06	31.55
1965	3.38	3.96	7.18	1.17	10.31	1.98	.55	2.60	4.98	2.02	5.15	2.57	45.85
1966	2.05	4.09	1.92	8.22	3.37	2.77	.33	8.95	4.57	.14	.10	2.36	38.87
1967	.30	.35	1.18	4.15	3.37	.28	2.46	2.29	3.53	5.30	3.38	4.00	30.59
1968	5.14	3.38	3.33	4.44	6.81	8.84	6.11	.54	3.67	.79	6.24	.59	49.88
Maximum	5.14	5.75	7.48	15.65	12.56	8.84	6.11	8.95	8.29	8.48	10.25	7.03	58.43
Minimum	.30	.35	.25	.52	.66	.28	.02	0	0	0	.10	.17	18.22
Average	2.26	2.66	2.53	4.03	4.46	3.59	1.62	2.02	2.64	2.40	2.99	2.50	33.71

[1] Rain gage at headquarters meteorologic station.

TABLE 5.—*Fertilizer use on conservation and nonconservation watersheds at Blackland Experimental Watershed, 1949–68*

Year	Fertilizer application [1] per acre on specified crop of—									
	Conservation watershed						Nonconservation watershed			
	Sequence A			Sequence B						
	Oats-sweet-clover	Cotton	Corn or grain sorghum [2]	Oats-sweet-clover	Corn or grain sorghum [2]	Cotton	Cotton	Corn or grain sorghum [2]	Cotton	Oats
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1949	0–90–0			0–90–0						
1950–60	32–40–0			32–40–0						
1961	48–60–0			48–60–0						
1962	0–68–0			0–68–0		48–60–0		48–60–0		
1963	48–60–0			0–90–0		48–60–0	32–40–0	32–40–0	32–40–0	32–40–0
1964–65	50–38–0			50–38–0		50–38–0	40–30–0	40–30–0	40–30–0	40–30–0
1966–68	50–38–0			50–38–0		50–38–0		40–30–0		40–30–0

[1] Total nitrogen (N), available phosphorus (P_2O_5), and water-soluble potassium (K_2O).

[2] After 1956 grain sorghum replaced corn in rotations except in few small fields; no corn grown in 1966–68. No fertilizer on grain sorghum in 1962.

TABLE 6.—*Crop yields from conservation and nonconservation watersheds at Blackland Experimental Watershed, 1938–68*

Year	Average yield per acre of specified crop from—							
	Conservation watershed				Nonconservation watershed			
	Lint cotton	Corn	Oats	Grain sorghum	Lint cotton	Corn	Oats	Grain sorghum
	Pounds	*Bushels*	*Bushels*	*Pounds*	*Pounds*	*Bushels*	*Bushels*	*Pounds*
1938	190.0	22.2	33.5		136.2	27.8	30.5	
1939	205.3	30.4	50.9		195.0	30.0	50.1	
1940	98.7	32.7	43.6		88.9	31.5	53.5	
1941	110.5	18.1	32.0		110.0	17.8	38.4	
1942	77.0	12.6	12.7		98.2	14.9	10.4	
Average	136.3	23.2	34.5		125.7	24.4	36.6	
1943	156.2	18.9	19.2		124.8	31.9	23.8	
1944	166.6	18.3	26.6		181.5	19.3	34.3	
1945	181.6	20.3	26.1		181.3	18.7	26.7	
1946	169.3	19.8	28.3		169.8	21.1	31.5	
1947	246.6	20.1	20.7		232.0	19.0	20.5	
Average	184.1	19.5	24.2		177.9	22.0	27.4	

TABLE 6.—*Crop yields from conservation and nonconservation watersheds at Blackland Experimental Watershed, 1938–68*—Continued

Year	Average yield per acre of specified crop from—							
	Conservation watershed				Nonconservation watershed			
	Lint cotton	Corn	Oats	Grain sorghum	Lint cotton	Corn	Oats	Grain sorghum
	Pounds	*Bushels*	*Bushels*	*Pounds*	*Pounds*	*Bushels*	*Bushels*	*Pounds*
1948	234.1	30.2	25.9		227.7	22.2	25.5	
1949	178.8	37.4	35.5		131.3	23.8	36.0	
1950	358.6	28.3	22.9		157.7	25.8	25.9	
1951	233.0	32.3	21.2		162.6	23.6	18.6	
1952	295.0	31.3	55.4		178.4	22.5	47.0	
Average	259.9	31.9	32.2		171.5	23.6	30.6	
1953	249.1	29.4	59.0		237.0	26.1	60.0	
1954	218.6	37.4	46.7		182.2	24.3	30.9	
1955	320.1	41.8	35.0		154.5	38.3	31.0	
1956	[1] 144.1	17.0	21.4		182.0	23.5	24.5	
1957	209.0	25.3	[2] 17.6	2,629	122.0	22.4	[2] 16.3	1,553
Average	257.0	30.2	35.9		175.5	27.1	32.5	

1958	241.9	34.0	34.2	3,338	137.6	27.1	22.6	2,304
1959	162.1	27.8	31.5	2,467	168.5	24.1	29.2	1,824
1960	128.8	35.6	35.6	2,587	89.2	22.6	20.2	1,592
1961	205.9	45.6	40.0	2,739	74.9	24.1	19.2	1,316
1962	233.2	39.5	28.0	2,925	90.2	36.3	18.3	1,390
Average	194.4	36.5	33.9	2,811	112.1	26.8	21.9	1,681
1963	313.0	34.6	31.4	3,161	143.3	40.4	38.6	3,052
1964	300.7	40.6	72.0	4,070	214.6	41.2	76.2	3,385
1965	307.6	33.2	46.5	1,743	184.5	48.8	55.5	1,072
1966	270.2	20.7	40.8	2,558	134.9	37.8	51.4	2,820
1967	186.2		41.2	3,456	100.4		38.8	2,811
Average	275.5	[3] 32.2	46.4	2,998	155.5	[3] 42.0	52.1	2,628
1968	165.0		49.5	1,407	89.5		38.3	1,237
31-year average	216.2	[4] 28.8	35.0	[5] 2,757	151.0	[4] 27.1	33.7	[5] 2,030

[1] Hail damage July 20, 1956; loss on conservation area estimated at 50 percent; estimated yield without hail 288.2 pounds per acre used in computing average yields.

[2] Yield low due to disease and wet spring.

[3] 4-year average.

[4] 29-year average.

[5] 12-year average.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1971 O—416-805